ORGANICS

FACT SHEET

See related Fact Sheets: Acronyms & Abbreviations; Glossary of Terms; Cost Assumptions; Raw Water Composition; Total Plant Costs; and WaTER Program.

1. CONTAMINANT DATA

A. Chemical Data: Organics is a term often used to describe any and all compounds, natural or man-made, which chemical structures are based in carbon. Natural organics include matter derived from a living organism, plant or animal, and occur as a result of byproducts or biodegradation of plant and animal matter. Man-made organic substances are called synthetic organic chemicals (SOC) and are synthesized from carbon and other elements such as hydrogen, nitrogen, and chlorine. SOCs commonly include the complete range of pesticides, various industrial chemicals and solvents, and household products. SOCs which are capable of vaporizing at relatively low temperatures are called volatile organic chemicals (VOCs). SOCs vary in water solubility and may not necessarily result in odor, color, or taste changes. SOCs are the subject of this Fact Sheet. Section 4 of this Fact Sheet lists the regulated SOCs along with the MCLs and BATs.
B. Source in Nature: SOCs in groundwater and surface water occur as a result of widespread use of pesticides (herbicide, fungicide, insecticide, bactericide, etc.); use of industrial chemicals and solvents (petroleum, detergents, etc.) in industry, manufacturing, agriculture, and around the home; and manufacture and disposal of modern products (styrofoam, plastics, cleaning compounds, paints, fire retardants, hair spray, etc.). SOCs occur both intentionally (pesticide application or manufacturing and industrial drainage) and accidentally (leaking USTs, chemical spills, backflow, or boating operations). SOC contamination also occurs as a result of leaching from industrial waste dumps/municipal landfills and storm runoff from urban areas. SOCs which leach into groundwater are a particular concern because the lack of light, heat, and oxygen retard chemical breakdown and dilution is less likely.
C. SDWA Limits: Refer to Section 4 for contaminant specific MCLs.
D. Health Effects of Contamination: Health effects vary based on contaminant toxicity level; contaminant concentration in the water; amount of water consumed or exposed to; contaminant absorption efficiency; and age, weight, and health of person exposed. Health effects can range from minor to severe, and acute or chronic. Some minor effects can include: nausea; vomiting; dizziness; drowsiness; lung/mucous membrane irritation; or skin rash. Some severe effects can include: cancer; vital organ damage; birth defects; nervous system disorders; and immune system damage. Contaminants are metabolically broken down (detoxified), excreted (urine, feces, exhaled, or sweat), or accumulated by the body. Those contaminants which accumulate in the body fat or tissue of fish, birds, or animals may be passed on through the food chain. Exposure routes include direct ingestion, respiratory inhalation, and skin absorption.

2. REMOVAL TECHNIQUES

A. USEPA BAT: Granular activated carbon or packed tower aeration (air stripping). (Glyphosate, Acrylamide, Epichlorohydrin, and THMs are exceptions, requiring alternate treatments and are not discussed in this Fact Sheet.) Refer to Section 4 for contaminant specific BAT. Consult with the equipment manufacturer and specifications to ensure the contaminant present will be removed.
! GAC uses extremely porous carbon media in a process known as adsorption. As water passes through the media the dissolved contaminants are attracted and held (adsorbed) on the solid surface. Benefits: well established; suitable for home use. Limitations: effectiveness based on contaminant type, concentration, rate of water usage, and type of carbon used; requires careful monitoring.
! Packed tower ASs use a tower filled with packing material, whereby water enters the top of the tower, is sprayed over the packing material exposing a thin layer of water to countercurrent air being blown in at the bottom. The process allows for mass transfer of the VOCs from water into air. AS off-gas is either discharged to the atmosphere or treated by vapor phase GAC. Benefits: well established; best suited for VOCs and large installations. Limitations: requires ample space; requires careful monitoring. GAC cost curves will be included in a future revision.
B. Alternative Methods of Treatment: Alternative AS types are available including countercurrent plate. Alternative treatment methods include carbon filtration, ultraviolet radiation, RO, ED, NF, and diatomaceous earth filtration.
C. Safety and Health Requirements for Treatment Processes: General industry safety, health, and self protection practices for process equipment should be followed, including proper use of chemicals and tools. When dealing with waterborne diseases, take precautions to prevent infection through open cuts/wounds, or illnesses from ingestion. Wear PPE and wash hands thoroughly.

3. BAT PROCESS DESCRIPTION AND COST DATA

General Assumptions: Refer to: Raw Water Composition Fact Sheet for ionic concentrations; and Cost Assumptions Fact Sheet for cost index data and process assumptions. All costs are based on *ENR*, PPI, and BLS cost indices for March 2001. General sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal are not included.

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3A. Granular Activated Carbon:

Process - GAC uses extremely porous carbon media in a process known as adsorption. As water passes through the highly porous media which has an extremely high surface area for adsorption, the dissolved contaminants adsorb on the solid surface. GAC is made of tiny clusters of carbon atoms stacked upon one another. The carbon media is produced by heating the carbon source (generally activated charcoal) in the absence of air to produce a high carbon material. The carbon media is activated by passing oxidizing gases through the material at extremely high temperatures. The activation process produces the pores that result in such high adsorption properties. The adsorption process depends on the following factors: 1) physical properties of the GAC, such as type of raw carbon, method of activation, pore size distribution, and surface area; 2) the chemical/electrical nature of the carbon source or method of activation, and the amount of oxygen and hydrogen associated with them, such that as the carbon surfaces become filled the more actively adsorbed contaminants will displace the less actively adsorbed ones; 3) chemical composition and concentration of contaminants, such as size, similarity, and concentration; 4) the temperature and pH of the water, adsorption usually increases as temperature and pH decrease; and 5) the flowrate and exposure time to the GAC, in that low contaminant concentration and flowrate with extended contact times increase the carbon's life. GAC devices include: pour-through for treating small volumes; faucet-mounted (with or without by-pass) for single point use; in-line (with or without by-pass) for treating large volumes at several faucets; and high-volume commercial units for treating community water supply systems. Careful selection of type of carbon to be used is based on the contaminants in the water, and manufacturer's recommendations.

Pretreatment - With bacterially unstable waters, filtration and disinfection prior to carbon treatment may be required. With high TSS waters, prefiltration may be required. If treatment is based on flowrate, a water meter may be required to register and total flowrates.

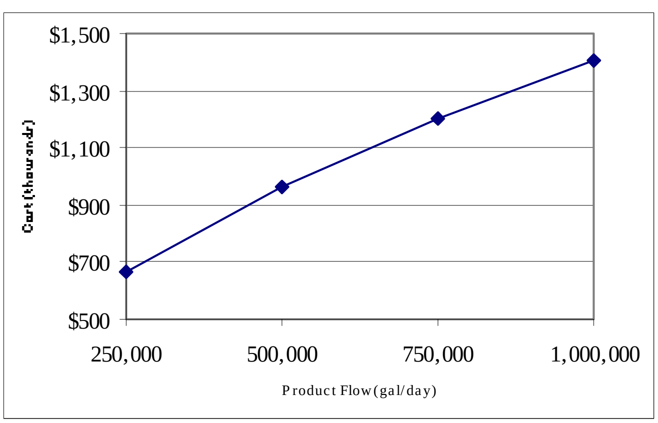
Maintenance - Careful monitoring and testing to ensure contaminant removal is required. Regular replacement of carbon media is required and is based on contaminant type, concentration, rate of water usage, and type of carbon used. The manufacturer's recommendations for media replacement should be consulted. Recharging by backwashing or flushing with hot water (145°F) may release the adsorbed organic chemicals. With bacterially unstable waters, monitoring for bacterial growth is required because the adsorbed organic chemicals are a food source for some bacteria. Flushing is required if the carbon filter is not used for several days, and regular backwashing may be required to prevent bacterial growth. Perform system pressure and flowrate checks to verify backwashing capabilities. Perform routine maintenance checks of valves, pipes, and pumps.

Waste Disposal - Backwash/flush water disposal is required if incorporated. Disposal of spent media may be offered by the contractor providing the media replacement services.

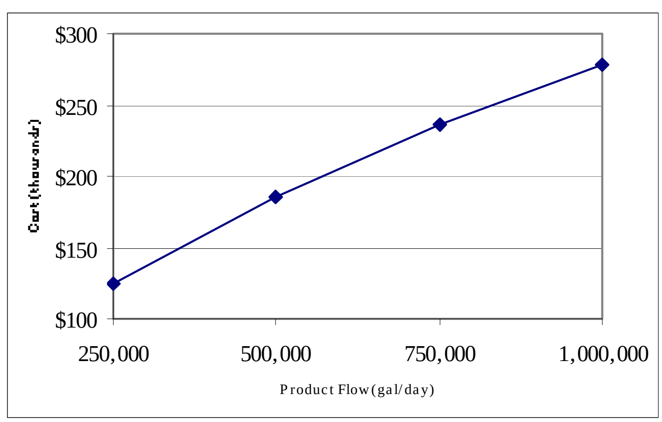
Advantages -
- ! Well established.
- ! Suitable for some organic chemicals, some pesticides, and THMs.
- ! Suitable for home use, typically inexpensive, with simple filter replacement requirements.
- ! Improves taste and smell; removes chlorine.

Disadvantages -
- ! Effectiveness is based on contaminant type, concentration, rate of water usage, and type of carbon used.
- ! Bacteria may grow on carbon surface.
- ! Adequate water flow and pressure required for backwashing/flushing.
- ! Requires careful monitoring.

BAT Equipment Cost*



BAT Annual O&M Cost*



*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.

3B. Air Stripping:
Process - AS is a physical separation process. Packed tower AS may use a tall, cylindrical tower filled with packing material. Water enters the top of the tower and is sprayed over the packing material exposing a thin layer of water to the countercurrent air being blown in at the bottom of the tower. The process maximizes the surface area of the water and allows for mass transfer of the VOCs from water into air. Maximum volatilization occurs when the water is evenly distributed and the countercurrent air is evenly applied, even when a load change occurs. Treated water exits the bottom of the tower, while air containing the volatilized contaminants is vented to atmosphere or treated by vapor phase GAC. Air emissions above Clean Air Act standards must be treated prior to release. A variety of packing materials are available, or plastic elements may be used in place of packing material. Auxiliary equipment can include: automated controls and level switches or safety features such as differential pressure monitors. Alternate types of ASs include: aeration tanks, spray aeration, shallow trays, columns filled with chemical resistant ellipsoids, or cascade-type internal components.

Vapor phase GAC is similar to liquid phase GAC. It uses extremely porous carbon media in a process known as adsorption. As air passes through the highly porous media which has an extremely high surface area for adsorption, the volatilized contaminants adsorb on the solid surface. The treated air is discharged directly to the atmosphere. Careful selection of type of carbon to be used is based on the contaminants in the air, and manufacturer's recommendations.

Pretreatment - Chlorination and dechlorination for routine cleaning of scale, slime, and clogging may be required. With high TDS waters, prefiltration may be required.

Posttreatment - Postdisinfection of AS effluent may be required. Polishing of AS off-gas and air discharge monitoring equipment may be required.

Maintenance - Careful monitoring and testing to ensure contaminant removal. Packed tower ASs are subject to chemical/physical scaling of the equipment as a result of hardness or sliming of the packing material due biological growth. Regular replacement of vapor phase carbon media is required and is based on contaminant type, concentration, rate of water usage, and type of carbon used.

Waste Disposal - Waste products (i.e. spent filters and cleaning solutions) require disposal in accordance with local, state, or Federal regulations.

Advantages -
! Well established.
! Effective, with removal efficiencies at 99% and greater.
! Best suited for VOCs and large installations.
! Packed towers are more effective, but tray configurations are less susceptible to fouling and are easier to clean.

Disadvantages -
! Requires design by knowledgeable, experienced individual with specifics on water flow rate, air-to-water ratio, influent concentrations, water temperature, and atmospheric pressure. Design is based on Henry's Law Constant, which describes the relation between the distribution of a substance in the liquid and the gas phases where ideal conditions exist. Computer programs are available to assist with modeling, and most manufacturer's have programs for modeling their specific equipment.
! Requires careful monitoring.
! Potential for inorganic/biological scaling, sliming, or clogging.
! Low volatility contaminants may require preheating; off-gas may require treatment.

Costs - The application of AS is extremely site specific. The costs of the equipment and operation and maintenance are based on the site specific organics and concentrations. Because the organics and concentrations vary greatly from location to location, a typical raw water analysis on which to base generic costs is impractical. For these reasons generic costs are not provided.

4. SOCs LIMITS AND BAT

CONTAMINANT	MCL (mg/L)	BAT
VOCs:		
Benzene	0.005	GAC, AS
Carbon Tetrachloride	0.005	GAC, AS
Dichlorobenzene (p-)	0.075	GAC, AS
Dichlorobenzene (o-)	0.6	GAC, AS
Dichloroethane (1,2-)	0.005	GAC, AS
Dichloroethylene (1,1-)	0.007	GAC, AS
Dichloroethylene (cis-1,2-)	0.07	GAC, AS
Dichloroethylene (trans-1,2-)	0.1	GAC, AS
Dichloromethane	0.005	AS
Dichloropropane (1,2-)	0.005	GAC, AS
Ethyl Benzene	0.7	GAC, AS
Monochlorobenzene	0.1	GAC, AS
Styrene	0.1	GAC, AS
Tetrachloroethylene	0.005	GAC, AS
Toluene	1	GAC, AS
Trichloroethane (1,1,1-)	0.2	GAC, AS
Trichloroethane (1,1,2-)	0.005	GAC, AS
Trichloroethene (TCE)	0.005	GAC, AS
Trichlorobenzene (1,2,4-)	0.07	GAC, AS
Vinyl Chloride	0.002	AS
Xylenes (Total)	10	GAC, AS
Pesticides/PCBs:		
Alachlor	0.002	GAC
Atrazine	0.003	GAC
Carbofuran	0.04	GAC
Chlordane	0.002	GAC
2,4-D	0.07	GAC
Dalapon	0.2	GAC
1,2-Dibromo-3-Chloropropane (DBCP)	0.0002	GAC, AS
Dinoseb	0.007	GAC
Diquat	0.02	GAC
Endothall	0.1	GAC
Endrin	0.002	GAC
Ethylenedibromide (EDB)	0.00005	GAC, AS
Glyphosate	0.7	Oxidation (chlorine or ozone)
Heptachlor	0.0004	GAC
Heptachlor Epoxide	0.0002	GAC
Lindane	0.0002	GAC
Methoxychlor	0.04	GAC
Oxamyl (Vydate)	0.2	GAC
Picloram	0.5	GAC
Polychlorinated byphenols (PCBs)	0.0005	GAC
Pentachlorophenol	0.001	GAC
Simazine	0.004	GAC
Toxaphene	0.003	GAC
2,4,5-TP (Silvex)	0.05	GAC
Other Organic Chemicals:		
Acrylamide	none set	TT with polymer
Benzo(a)pyrene (PAH)	0.0002	GAC
Di(2-ethylhexyl)adipate	0.4	GAC, AS
Di(2-ethylhexy)phthalate	0.006	GAC
Epichlorohydrin	none set	TT with polymer
Hexachlorobenzene	0.001	GAC
2,3,7,8-TCDD (Dioxin)	0.00003	GAC
THMs (Chloroform, Bromoform, Bromodichloromethane, Dibromochloromethane)	0.1	Chloramines, Chlorine Dioxide, improved clarification for THM precursor reduction, moving chlorination point to reduce TTHM, or powdered activated carbon.

The SDWA regulates contaminants in community water supply systems, therefore contamination is more likely to go undetected and untreated in unregulated private water systems.